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ABSTRACT

Details of the remedial mathematics programs offered by three community colleges in the Washington D.C. area and a short description of programs offered by eight Maryland community colleges are given. Research and studies of remedial programs at the community college level in other parts of the United States are briefly reviewed. (DT)

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# THE TEACHING OF DEVELOPMENTAL MATHEMATICS IN COMMUNITY COLLEGES

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A Project Report Presented
to Dr. Richard Frankie of
George Washington University
for course completion of
Education 371

by

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## INTRODUCTION

A welcome new era has emerged on the American scene, that is, the era that has ushered in the community college. Low costs and open door policies have brought advanced education into the realm of reality for thousands who, in another decade, would have had to settle for only a dream. Colleges such as Montgomery College in Rockville, Maryland are seeing their doors swell with enrollments of over 10,000 students and are anticipating still more. To bring advanced education into the reach of everyone is certainly a symbol of our American democratic ideals. But with these open door policies come problems. What to do with the student who is inadequately prepared for college material. Most community colleges have thus set up remedial programs to bridge this gap. There is, unfortunately, a dirth of research in this field. What little there is concerns itself with inconclusive results, inadequate samplings and lack of direction. Thus, it is hoped that the discussion that follows will present an overview of programs being used by some of the prominent community colleges in the Washington, D..C. metropolitan area with a discussion of some of the pertinent research that has been performed thoughout the United States. I wish to thank Mr. Wm. Swyter of Montgomery College, Dr. David Shore of Prince George's Community College and Dr. David Conroy of Northern Virginia Community College

for their assistance and patience.

## VISIT TO MONTGOMERY COLLEGE

Students entering Montgomery College in Rockville, Maryland are selected for the remedial mathematics program on the basis of ACT scores and high school grades. Hopefully, according to Mr. W. Swyter, chairman of the mathematics department at Montgomery College's Rockville, Maryland campus, the ACT will be replaced ikn the future by a more reliable evaluator.

The student has a choice between two courses, 1) Basic Arithmetic and 2) Math 10 (functions, graphs, general review of high school math . Basic Arithmetic is exactly what it says, teaching the fundamentals of arithmetic to students lacking the basic skills (present enrollment is 40-50 students). It is a more structured course in a more rigid classroom procedure. Math 10, although a structured course, is much more flexible. The night program uses regular classroom lecturing procedure, but the day program uses a programmed text with a structured testing program. There is no time limit for completing the course but the course carries a grade of "x" until it is completed. The student can: a) complete the course successfully for a conventional grade and credit,

b) complete all but a few bits so that he can register for the next course (gradeI ),

c) continue working at his own speed (grade X), OR

d) can withdraw within eleven weeks (Montgomery College has a fifteen week semester)

The class meets for three hours each, 2 hours of classroom instruction with one hour of audio tape work in the math lab. The math lab is large with individual listening booths. An instructor is always present, although the student works at his own pace by himself with the materials. The tapes consist of lectures followed by exercises with answers. A tape lasts from 25 minutes to one hour. The student takes a practice test, then can retake the "test" three more times. Tests are only informational since the grade comes from the test covering the entire book. This test may be taken as many as three times for a passing grade. H e must get 8 out of 10 correct for a passing score. The final examination counts for half of the grade and has a correlation of more than 70% with success in subsequent math courses.

This programmed text with its accompanying audio tapes is considered by Montgomery College instructors to be superior to the old lecture method. Learning has been improved and tension has been reduced since the student can listen to the same lecture as many times as he wishes with an instructor always present. Students have tutoring available since teachers are required to be available for 3 hours each day. The students are also encouraged to go back to their previous high school teachers for help.

Montgomery College's remedial math program indicated that teaching aids are just that -- aids - but the knowledgeable instructor is still all important. It is unfortunate that , as Mr. Swyter pointed out,"Ph.D's are teaching arithmetic" instead of having teachers trained to teach those with learning problems. Remedial classes require experienced teachers rather than accomplished mathematicians. Success appears to lie in the fact that students progress at their own pace with adequate instruction always available.

PRINCE GEORGE'S COMMUNITY COLLEGE

In August, 1972, a memorandum was sent out to the faculty of Prince George's Community College to state officially that previous Developmental Mathematics Courses 001 and 002 would henceforth be consolidated into one Developmental Mathematics Courses, MATH 005. The purpose was to eliminate the confusion involved in directing a student into the proper course appropriate to his needs. Everyone requiring pre-college-level instruction in mathematics would be assigned to MATH 005. Once in this course, the student sould have his choice of ten programmed textbooks to complete that ranged in content from basic arithmetic to trigonometry (See below). For example, the science major would need to complete more texts than would a sociology major. Successful completion would be measured by correct scores on tests of at least 80%.

Here again, the student works independently at his own pace with the teacher serving primarily as a tutor for augmentation of the programmed texts. MATH 005 may take from one to three semesters for completion and is considered equivalent to three semester hours at the college.

Guidance counselors are in the developmental section as a further aid to these students. The Developmental Studies Division believes that too many of these students identify with defeat and failure and thereby have difficulty in establishing and adapting themselves to their academic goals. In counseling these students toward realistic goals, the counselors are considered a very necessary part of the success of the remedial program.

Also, the faculty at the Prince George's Community College believe in the importance of adequate communication among the departments and

and between the College and the community. There is, presently, an articulation committee between the school district curriculum office and the various departments of the college, and there are efforts being made to set up additional articulation committees between the school district and various other committees. Hopefully, this increased communication should result in better preparation of forthcoming freshmen.

The teamwork between the Developmental Studies Division and the Mathematics Department of Prince George's Community College are producing successes, not yet formally measured. The constant innovations sought out and tried leave insufficient time for statistical studies. Perhaps this will come later.

EXCERP FROM MEMORANDUM OF PRINCE GEORGE'S COMMUNITY COLLEGE

"August 16, 1972

The following charts describe the materials used in the course (MATH 005), and show how the student's choice of curriculum will be used to determine which materials he or she must complete. All the texts currently used in the course are programmed.

| CODE | TEXT |
|---|---|
| A | Fundamentals of Arithmetic; Michael Eraut; McGraw-Hill |
| B | Contemporary Algebra-Book 1; Heimer, Kocher, Lottes; Hol, Rinehart and Winston |
| C | Contemporary Algebra-Book 2; Heimer, Kocher, Lottes; Hol, Rinehart, and Winston |
| D | Basic Geometry - text to be determined |
| E | Basic Trigonometry - text to be determined |
| F | Basic Work, Mixture, and Motion Problems; Denmark; Houghton |

| | | | |
|---|---|---|---|
| G | Algebra 1; | Alwin and Hackworth; | Prentice-Hall |
| H | Algebra 2; | Alwin and Hackworth; | Prentice-Hall |
| I | Algebra 3; | Alwin and Hackworth; | Prentice-Hall |
| J | Algebra 4; | Alwin and Hackworth; | Prentice-Hall |

| Preparation for | Refresher Work | Required Work | Optional Work (to fill our sem.) |
|---|---|---|---|
| Math 103 | | A,B | C,D,E,F |
| Math 105 | | A,B | C,D,E,F |
| Math 106 | | A,B | C,D,E,F |
| Math 151 | | A,B | C,D,E,F |
| Career Nursing | | A,B | C,D,E,F |
| Math 109 | A(Chap. 1-6) | F,G,H,I,J(Ch.1-2) | D,E,J(Ch.3-4) |
| Math 117 | A(Chap. 1-6) | F,G,H,I,J | D,E |
| Math 161 | A(Chap. 1-10) | D,E,F,G,H | I,J |

NORTHERN VIRGINIA COMMUNITY COLLEGE

Northern Virginia Community College is expanding its facilities to become one of the major junior colleges in the Virginia area. The Developmental Division at each of its five outlying campuses is directed by a coordinator who oversees both mathematics and English. Remedial mathematics, at the Annandale Campus, is directed by the assistant director of the division, Dr. David Conroy.

There were approximately nine hundred students in the developmental mathematics program at the Annandale Campus during the fall quarter, 1972. The Alexandria Campus also had a substantial enrollment of several hundred students. The Woodbridge, Manassas and Loudoun Campuses have one class each, even though the buildings have not yet been constructed. The program consists of lecture classes: (a) arithmetic (math 06); (b) algebra I (math 31); (c) algebra II (math 32); (d) geometry (math 36); and (e) trigonometry (math 38). Each of these lecture classes has a programmed course on the same level to correspond with it (math 01). The student may choose the lecture approach or the programmed approach when taking developmental math courses. If he finds himself falling behind in a lecture class, he may transfer to programmed math in order to progress at his own pace. Placement in the classes is determined by diagnostic tests administered at the beginning of each quarter.

The arithmetic text in the programmed course is called, "Success in Math," by Motivation Development Inc. This arithmetic section progresses through percentage. The algebra programmed texts are the Algebra series by Alwin and Hackworth. These books progress through algebra II. There are also programmed texts for geometry and trigonometry. Dr. Conroy stated that he and his staff are constantly working to improve the instruction especially through supplemental individualized learning packages in an attempt to tailor instruction more and more to individual student needs. The programmed courses seem more popular than the lecture courses since the student can progress at his own rate and can study only the sections in which he is weak.

As for teaching aids, tapes are made at the College to augment both methods of instruction. There are minimal problems when introducing these aids to the students and making them readily available since some students are reluctant to use inanimate teaching aids. The most successful teaching method--lecture or programmed study--depends for its success on whether the student himself chooses that particular method. In other words, self-motivation is a very significant factor.

The student is admitted to Northern Virginia Community College if he has a high school diploma and/or is eighteen years old or older. He is graded by

S: satisfactorily finished the course

R: satisfactory progress but must re-enroll for success in the course

U: unsatisfactory--did not make satisfactory progress in the course and needs counseling.

He is graded on his tests, not by a letter grade or necessarily by a numerical grade but by indicators which establish that he has satisfactorily achieved the objectives of specific topics as for example, two out of three problems correct or three out of four correct (depending on the test). He can take a course for as many quarters as he needs (the year consists of four quarters of ten weeks each). However, if he does not complete the course in three quarters he is requested to seek counseling for a re-evaluation.

Here, again, Dr. Conroy stressed the necessity for counseling the students. As he said, these are working students with many problems and many needs. He felt that the teacher must be more than a mathematician; he must have insight and feeling for students. He must enjoy teaching the course and be able to convey that feeling to others.

At the end of the course, the students rate the course. Much of the rating is subjective, but the objective comments do have great value in improving the program. In addition, annual follow-up studies indicate that the instruction itself is effective in preparing the student for success in higher level subjects. Innovation and constantly striving to better the program are keynotes of the evaluation process.

Success appears to lie in the availability of trained teachers, the effort to gear audio-visual aids to the particular student and the reduction of tension for accomplishment within a definite time limit. Perhaps, too, success of the program is due to the fact that Developmental Mathematics is part of a separate Developmental Division of the college instead of simply a break-off from another department.

## PROGRAMS AT OTHER MARYLAND COMMUNITY COLLEGES 10

ANNE ARUNDEL COMMUNITY COLLEGE

Two courses, Math 001 and Math 002, are the offerings in Developmental Mathematics at Anne Arundel Community College. The teaching method is primarily lecture and a single text is used in each course. Placement is made on the basis of high school grades and the ACT test.

CATONSVILLE COMMUNITY COLLEGE

One course, Math 9, is offered for Developmental Mathematics at Catonsville Community College. There is one text, a programmed text, Elementary Algebra.

CHARLES COUNTY COMMUNITY COLLEGE

One course, Math 100, is offered for Developmental Mathematics. One text is used, taught by the lecture method.

DUNDALK COMMUNITY COLLEGE

One course, Math 100, is offered for Developmental Mathematics. The text used is Programmed Algebra, Parts I and II by Alvin and Hackworth.

ESSEX COMMUNITY COLLEGE

One course, 001, Basic Mathematics Review Program, is divided into six units. The student works at his own pace with programmed texts in a program tailored to the individual's remedial needs.

FREDERICK COMMUNITY COLLEGE

Math 050-051 consists of a two-semester mathematics laboratory and utilizes four sequential programmed texts.

GARRETT COMMUNITY COLLEGE

Garrett Community College has no developmental program due to its extremely low enrollment.

HAGERSTOWN JUNIOR COLLEGE

One course, Math 100 (Introductory Algebra) is offered, utilizing four different programmed texts. Class size is limited to 25 students.

## PROGRAMS IN OTHER PARTS OF THE U.S.A

Some studies have made on the advisability of providing remedial work. In the summer of 1970, Santa Barbara City College began a developmental program for dicadvantaged minority students. Tifty-two students participated. The minority students were enrolled in the regular college courses, differing only in that they were provided with assistance from the school's tutorial center. The students were alike in that they scored low in self-concept as well as in academic achievement. The result of the developmental program was that 46 of the disadvantaged students could be encouraged to take higher education if financial aid and tutorial assistance were more available.[1]

A study was made in September, 1970 to determine the effectiveness of remedial courses and of the policies and instruments. Rondomly selected junior college students were compared as to ability, interest, activation, persistance and performance for the following groups: 1) those needing to take remedial courses but placed in regular courses, 2) those who enrolled in regular courses after passing remedial courses and 3) those who did not require remediation. The mathematics remedial course was found to remove dissatisfaction with the regular courses and to do so to a more significant degree than did remedial programs for other courses.[2]

In a paper presented at the annual meeting of the American Educational Research Association in February, 1970, the remedial program at the Miami Dade Junior College was described. Students were placed in the remedial programs on the basis of high school grades or a score of 22 or less on the School and College Ability Test. It was concluded that the remedial program did not make

any meaningful difference in student withdrawal from college, was not effective in raising point average during the second semester above a "C" and did not result in any appreciably better learning when compared to a control group the members of which were not placed in remedial classes.[3]

Interesting results for remedial courses in junior colleges, particularly for schools having a large number of culturally deprived students, will be obtained with the next three years. A three-year plan has been adopted by the Appalachian Consortium Special Development Project in North Carolina to educate the low income and educationally deprived citizens of Appalachia. It will include basic research in relation to short and long-range program planning, implementation and evaluation of selected programs and further evaluation and possible program revision. In the first year, the following research areas will be studied: 1) a comprehensive community survey including a business-industrial survery, 2) development of student profile data and exchange of aggregated results, 3) follow-up studies of alumni and drop outs and 4) image studies to determine the way programs and services are received by the community. The results should prove interesting for the future of remedial teaching.[4]

Studies have also been made to determine the popularity and assessment of remedial programs by junior colleges. Jack Beal, a graduate assistant at the University of Nebraska conducted a study in October, 1970, to analyze remedial mathematics in the junior and community colleges.[5] The study was based on useable responses from 98 community and junior colleges during the fall and winter of 1969. Letters were mailed to 185 colleges listed in the 1968 Directory

of American Association of Junior Colleges. It asked: 1) What mathematics remedial courses were offered; 2) What was required; 3) Criteria of selection of students; 4) Criteria of selection of teachers and 5) Most common instructional technique.

Of the 185 schools originally contacted, 42 specifically indicated no such program and 6 questioned the appropriateness of such a course. Some reasons for "no program" were lack of need and lack of staff. Eighteen did not reply. The most often indicated reasons for the existence of remedial programs were to enable students to continue in regular college mathematics or to satisfy prerequisite requirements for some other non math courses. Basic algebra, intermediate algebra, arithmetic and Euclidean geometry were the courses most frequently offered.

In selecting students for remedial programs, standardized tests, previous grades and counselor recommendations were the most often used criteria. Enrollment in remedial courses included at least 20% of all mathematics students at 51 of the schools. Enrollment in subsequent mathematics courses by continuing students reached an average of 39.4% in 51 of the colleges. Entrance into these non-remedial courses was based largely on attaining a C or D in the remedial courses. More than half of the faculty in each school was involved in the program and the major bases for selection of teachers for the remedial programs included rotation, interest and understanding of the under-achiever.

Only 26 of the respondents indicated efforts to evaluate their

program. The techniques listed as most commonly used were

| TECHNIQUE | NO. OF SCHOOLS RESPONDING | % |
|---|---|---|
| Lecture | 85 | 40.0 |
| Discussion | 83 | 35.1 |
| Individual Instruction | 67 | 24.2 |
| Programmed texts | 30 | 35.1 |
| Teaching Machines | 6 | 12.8 |

Mr. Beal pointed out the dominance of the lecture-discussion system of teaching. He also suggested the necessity for special training of teaching for remedial mathematics programs in junior colleges today.

As for teaching methods for remedial programs the literature seems to support the use of audio-visual aids as a supplement rather than as a substitute for teaching as pointed out by Wilbert J. McKeachie is his book, Teaching Tips. He concluded that television instruction is inferior to classroom lectures in communicating information, developing critical thinking, changing attitudes and arousing interest in a subject but that this inferiority is probably not great. Chance in 1961 found that the use of overhead projected transparencies and overlays was significantly superior to conventional instruction in teaching descriptive geometry to freshmen engineers. He summarized by saying that research at present reveals no likelihood that they will eliminate the need for face-to-face contacts between professors and students.[6]

Siegal and Siegel (1964) report that personal contact with the instructor was important for acquisition of concepts by three types of students: those with low motivation; those unsophisticated in the subject-matter field and those predisposed to learn facts rather than to apply and synthesize. To the extent that remedial work

is aimed at rectifying what must have been defects in the learning sequences by which a skill was acquired, remedial work is a form of educational counseling, and is close to the work of a teacher. To the extent that remedial work deals with the emotional and motivational factors as sources of the difficulty, it becomes a form of psychological counseling.[7]

In another study, the audio-tutorial practices and evaluations at 91 California and 25 other junior colleges in the United States were surveyed. 70 indicated present or future use of audio-visual devices, noting that their use did not lessen the teacher's load. Based on the data received, the following conclusions were drawn:

1) despite the large amount of work required for preparation of audio-tutorial instruction, those instructors using it were much more enthusiastic about the method than those who largely used the lecture method.

2) Students in the audio-tutorial program do learn more in less time, probably because the courses are oriented more toward student learning that teacher preparation and delivery.

3) Students are more enthusiastic after experiencing both lecture and audio-tutorial methods.

4) Instructors are provided with greater opportunities to manage their educational environment by providing content and curricular restructuring opportunities.[8]

In a study comparing three methods of teaching remedial algebra in junior college, the traditional lecture-discussion, a multi-method approach and programmed instruction, Marilyn Beck determined that although each method seemed to have certain specific

advantages over the others, no method showed any significant superiority to any other in effecting later programs in college-level mathematics.[9]

In a speech at the American Association of Junior College National Convention of Deans of Instruction, an experiment was described in which known underachievers were combined at random with regular enrollees. The purpose was to appraise differences between the lecture method and individual instruction. The instruction method was one of making the student-teacher relationship cooperative instead of authoritarian. Teachers fulfilled their contracts by giving individual help; students fulfilled their contracts by completing their assignments. It was noted that 1) no correlation existed between IQ and performance; 2) teachers must reject their accustomed teaching habits; 3) students must be aware of methods, objectives and criteria; 4) the underachievers and the control group were not dissimilar enough for contrast; 5) factors besides ability are critical to college success. The teacher must know his students, motivate them and avoid isolating himself from them. The students felt they had achieved learning for the sake of learning, achieved experience in self-management and had enjoyed being treated as people. The experiment seemed to give a new dimension to teaching college-age students, whether remedial

or otherwise, i.e., they profit by their participation in the learning process.[18]

Research performed by Florence Miller in 1969 investigated the difficulties in identifying who should take the remedial course.[19] In a study she conducted, difficulty was found with the use of ACT to determine placement into mathematics courses in much the same way that Montgomery College is finding dissatisfaction.

Dr. Miller was concerned with placement into Math 101 at Wilbur Wright College, Cook County, Illinois. In the 1950's, a placement test was devised which proved unsatisfactory. Then, by using a system whereby questions were chosen according to the ability or lack of it shown by selected students, a new test was devised. Faculty members considered it to be reliable, but too time consuming. The result was the selection of the ACT test with a required minimum score of 17-21 and 1 year of algebra with 1 year of geometry as a requirement for regular math courses.

In 1965, though, Dr. Gray, a member of the staff, found little correlation between ACT and success. It was found by Paul Trump, president of the American College Testing Program, that tests are most useful when used in combination with high school grades and other kinds of information. Thus, Barron's Guide to the Two-Year Colleges states that most college officials make their estimates of an applicants chance of success on the basis of high school and rank in class. L. Joseph Lind, Allan P. Abell and H. Clifton Hutchens found limited relationship between the ACT, or the CQT and the first semester's academic performance.

Dr. Miller says that one must watch out for the student with

high measurable ability who has not achieved success since mathematical ability is closely tied to intelligence. Possible reasons for lack of success are inadequate motivation, negative attitude or lack of insight into areas of learning. Possibly the difficulty in identification of the remedial student accounts for the lack of total success with remedial programs. Once better identifiers can be found, better teaching aids and devices may be formulated.[12]

As we can see, the open door policy of community colleges has brought its problems, in particular, how to teach mathematics to students who, for a variety of reasons, have never mastered it well enough to attempt college level courses with any hope of success. Much of research is based on isolated classes and evaluated by subjective means. There are no clear conclusions, nothing other than statements of what worked best in particular situations. The purpose of this paper was to present a report of remedial methods being used in selected places. Perhaps the future will present research with more statistical data so as to better improve our success with remediation.

FOOTNOTES

[1]"The Summer Readiness Program: Neighborhood Youth Corps at Santa Barbara City College," (Santa Barbara City College, California, Office of Research and Development, September, 1970) ERIC, ED 042 441.

[2]"Description of Determining Effectiveness of Present Remedial Courses, Policies and Instruments," (September, 1970) ERIC, ED 051 795.

[3]"Do Remedial Programs Really Work?" (paper presented at the Annual Meeting, American Educational Research Association, New York, February, 1970) ERIC, ED 046 975.

[4]Elmo V. Rossler, ed., "Appalachian Developing Institutions Consortium, Progress Report No. 1: First Six Month of Consortium Activities," (Washing, D. C.: Office of Education, January, 1972) ERIC, ED 058 874.

[5]Jack Beal, "An Analysis of Remedial Mathematics in Junior Community Colleges," (Washington, D.C.: Department of Health, Education and Welfare, October, 1970) ERIC, ED 043 335.

[6]Wilbert J. Mc Keachie, Teaching Tips, (Lexington, Massachusetts: D.C. Heath and Co., 1969) p. 114.

[7]Ibid., p.197

[8]"Audio-Tutorial Practices in California Community Colleges, Preliminary Report," (Pleasant Hill, California: Diablo Valley College, July, 1970) ERIC, ED 042 452.

[9]Marilyn Clark Beck, "A Comparative Analysis of Three Methods of Teaching Remedial Algebra on the Junior College Level" (unpublished Ed. D. dissertation, Auburn University, 1970)

[10]Annual Newsletter, 1971-1972 of the Mathematics Division of the Mathe Maryland Association of Junior Colleges.

[11]Benson R. Schulman, "Teaching the High Ability, Low Achieving Student: Indivisualized instruction in Action, An Attack upon Human Isolation," (Speech delivered at the AAJC National Convention of Deans of Instruction, University of California, Los Angeles, July, 1969) ERIC ED 032 046.

[12]Florence M. Miller, "An Evaluation of Some Predictors of Success in College Mathematics," (unpublished Ed. D. dissertation, Loyola University, Chicago, 1969)